TORNADOES IN MISSOURI [1]

By W. S. BELDEN

[Weather Bureau Office St. Joseph, Mo.]

Mr. W. S. Belden in charge of the Weather Bureau Office of St. Joseph, Mo., reports the occurrence of at least four tornado funnel clouds, three of which were first seen over the Missouri River a little north of White Cloud, Kans., about 6 p. m. May 1, 1930. One moved nearly due east for a distance of about 5 miles and disappeared a little south of Napier, Mo. Another moved northeasterly a distance, approximately, of 11 miles from Mound City to a point north of Maitland, Mo. Each of these two tornadoes advanced rather slowly, with paths of destruction ranging from 50 to 100 yards in width. The third tornado apparently did no damage.

Destruction from a funnel-shaped cloud began 4 miles southwest of Rosendale at about 6:15 p. m. The cloud traveled eastward causing much damage for the first 2 miles, then lifted for a distance of 4½ miles. Again reaching to the ground, it shifted its course to the south and southeastward for 3 miles, after which it continued in an easterly direction with wider path, nearly a mile in places, and undiminished violence, ending approximately 1 mile south of Union Star. This tornado left unusually wide trails of destruction, having a total length of slightly more than 10 miles.

The last of the group of tornadoes was first observed 4 miles north of Filmore at about 6:20 p. m. It moved northeastward 4 miles, then followed a sinuous course eastward for nearly 3 miles, and turned southeastward for about 1 mile on the west side of the One Hundred and Two River Valley, after which it turned eastward again, crossed the river and disappeared one-fourth mile south of Bolckow. The path of the funnel-shaped cloud varied from 100 to 200 yards in width and was continuous for 8 miles.

No lives were lost in these violent storms and no one was seriously injured. Many escapes were made in automobiles when the tornadoes were observed approaching, while others took refuge in caves, cellars, and basements. Approximately 60 homes were damaged or totally destroyed and a much larger number of other farm buildings were demolished. One school building and one filling station were also wrecked. Numerous farms suffered serious losses of machinery, livestock, trees, and fences, but there was little damage to growing crops, such as wheat, oats, and alfalfa. Clearing fields of débris involved much labor.

A conservative estimate of the total loss in both Holt and Andrew Counties as a result of these tornadoes has been placed at $200,000.

[1] While the 2 groups of tornadoes, those of Missouri and Michigan, were directly related to the same cyclonic storm, it is scarcely possible that there was a trail of tornadic storms from northwest Missouri to the eastern shore of Lake Michigan at and near to Grand Rapids. Rather it is preferred to believe that the Michigan group originated in the early hours of May 2 and were due to the same initial cause or causes that produced the Missouri storms about 12 hours earlier.—*Editor.*

NOTES, ABSTRACTS, AND REVIEWS

Limiting values of temperature.—A correspondent calls our attention to a statement which appeared in this REVIEW, 57:513, to the effect that the highest temperature ever recorded with standard thermometers in a standard shelter was 134° F. (56.7 C.) at Greenland Ranch in Death Valley, Calif., and points out that a higher temperature, 136° F., has been reported for Azizia, in Tripoli. Our examination of the temperature records for surrounding stations made some time since led to the suspicion that that reading was more or less in error. Our suspicions have since been confirmed by Dr. G. Hellman, as may be seen from the following excerpt from his article on "Limiting values of climatic elements on earth.[1]

For a long, long time the question as to the highest temperature observed on the earth has been of great interest, but it is difficult to answer it with certainty, since the exact determination of high air temperatures encounters great difficulties on account of the not easily eliminated error due to thermometer exposure or, with aspirated and sling thermometers, on account of radiation from the ground. When the ground in the desert is heated to 158° F. it is difficult to prevent ground radiation from affecting the thermometer. It may, therefore, be assumed as a matter of course that the maximum temperatures recorded are rather too high than too low, and the error may be taken as approximately two-tenths of a degree.

The highest temperature recorded in a fixed shelter (United States shelter of the Stevenson screen type) was 134° on July 10, 1913, in Death Valley, Calif. This unusual heat, which was probably exceeded at the lowest point in the depression, occurred in a 7-day period of extraordinary heat, which gave the following maxima:

July, 1913

8th	128°	11th	129°	13th	131°
9th	129	12th	130	14th	127
10th	134				

In all probability such a series of extreme temperature values rarely occurs even in Death Valley.

In the interior of New South Wales 129° and even 131° were recorded on January 21, 1845 (Hann *Klimatologie* III, 485). At several points in the North American desert, comprising parts of Arizona, California, and New Mexico, for example, Salton, Mammoth Tank, and Mohawk Summit, there have been recorded maxima of 124° to 130° (ibid. III, 425 ff.). At Basra, on the lower Euphrates, 129° was read in July, 1921 (Quarterly Journal, Royal Meteorological Society, 1922, 278). Rohlfs recorded a temperature of 127° in Kauar Oasis (19° N., 13° E.) and values almost as high in the desert region of India; Jacobabad, 126° on July 13, 1897.

We read here and there of still higher temperatures than those just mentioned, but they are either to be immediately characterized as false or so questionable and improbable as not to merit mention here. (See *Meteorologische Zeitschrift*, 1893, pp. 62 and 279.) I believe that we may accept 131° to 133° as the highest observed temperature that is sufficiently authenticated; the temperature of 134° recorded in the shelter in Death Valley is probably 2° or more too high on account of the influence of radiation in heating the shelter, which was at only moderate height above the ground.

Recently I noticed in the Quarterly Journal of the Royal Meteorological Society, 1924, page 324, and in the

[1] Sitzungsberichte der Preussischen Akademie der Wissenschaften. Physikalisch-Mathematischen Klasse. XI. 1925.

Meteorologische Zeitschrift, 1925, page 39, that according to a statement by F. Eredia in his paper, *Il clima di Azizia, Tripolitania*, there was recorded at Azizia, about 30 miles southwest of Tripoli, a maximum temperature of 136.4° on September 13, 1922, under conditions of cloudless sky and wind from the southwest. At once it appeared to me as striking that a temperature so high should occur relatively near the sea and in a region of only semidesert character. A comparison with the remaining Tripolitanian stations in the *R. Ufficio Agrario, Sezione Meteorogica, Nr. 4, 5*, showed that the reading is about 20° higher than the maxima on the same day and on the preceding day at other stations: Tripoli, 115°; Sidi Mesri, 111°; Homs, 112°; and Zuara Marina, 117°. Also in the year 1923, when the publication gives 135° as the maximum for Azizia, all of the remaining stations, nine in number, have maximum temperatures 18° or more degrees lower. On the other hand it appears to me to be striking that the minima observed at Azizia are lower than those recorded at the other stations. I am, therefore, inclined to believe that there is defective shelter against radiation or that the thermometer is located in a hollow.—*A. J. H.*

Memoir of the Institute of Meteorology, No. 1—Climatic Provinces of China by Coching Chu.—Published by the Institute of Meteorology, National Research Institute, Nanking, China, April, 1929.—The Nanking Institute of Meteorology established under the auspices of the Research Institute of China, has devoted its first memoir to the question of climatic Provinces of China. Dr. Coching Chu, the director of the new service, and to whom we already owe several contributions to climatological literature on China through his various articles appearing in the MONTHLY WEATHER REVIEW from time to time, points out in his discussion the different criteria that are necessary for the classification of a climate of a country so extensive in area and so diversified in climate as China.

The first part of the memoir is a collection of eight maps—three maps of climatic Provinces of China, one by Koeppen, one by Emm. de Martonne, and one of the new classification submitted by the author; one rainfall map of China by Gherzi; a mean annual isothermal map of China by H. Gauthier; July and January Isothermal maps of China by H. Gauthier; and a hypsometric map of China.

Following the maps is a discussion of 11 pages in which the author discusses the relative merits and demerits of the different classifications referred to in the first part of the memoir, including Prof. Jules Sion's summary, from his book "Asie des Moussons."

In his own classification of the climatic Provinces of China, the author divides China into eight major Provinces based upon the criteria of mean annual temperature, annual range and mean annual precipitation, and also in two Provinces, the mean temperature of the coldest month, and, in two others, cyclones, typhoons, and altitude.

The remarks "In China proper, where the rainfall is abundant, temperature becomes the vital factor" and "with a few exceptions such as Tsingtao, the maximum temperature in China usually occurs in the month of July," are either misleading or need qualification. We sincerely wish the first remark were true, so that the loess highland could enjoy rain equal even to that of Chili, and so that the North China plain would be freed from the agony of famine. In the second remark, the "few exceptions" seem to be too many to be exceptions, for out of the records of 100 stations only 52 stations have July maximum.

The author's distinct contribution lies in the attempt to correlate the climatic provinces with vegetation. Since the paper is a very sketchy one, little information is offered for study. Yet it serves to emphasize the relation between life and climate as a criterion for the classification of climates. The paper serves as a stimulus to a problem for investigation rather than a solution of a problem.

The discussion is concise and clear. The maps are simple but definite. The study of climatology in China, however, is only in its infancy, owing to the lack of data in the inland regions and the lack of knowledge of the upper air. Thus, it is only as in a very dim light that the outline of Chinese climate is distinguishable while the detailed special features are still veiled. Pioneer meteorologists, therefore, have to feel their way to mark off provinces on the map. We can not but deeply appreciate the effort and contribution of Doctor Chu to the climatology of China.—*Liu En-lan.*

Persistence of a pronounced inversion above stratus clouds after the latter had dissipated, by L. T. Samuels.—Figure 1 shows the vertical temperature distribution over

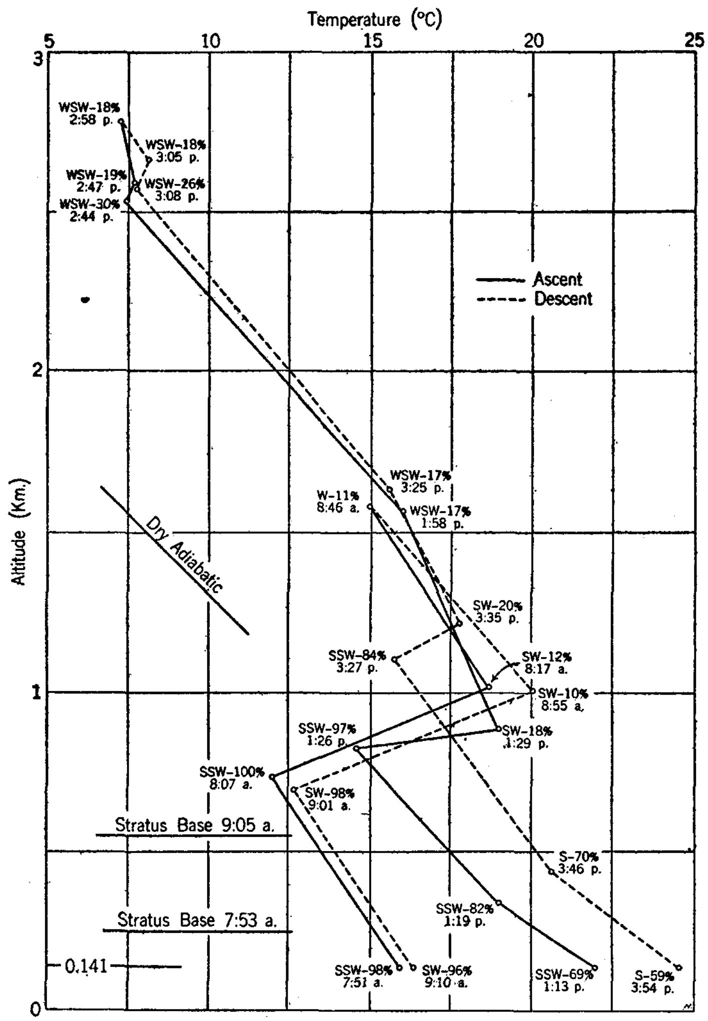

FIGURE 1.—Temperature (° C.) Groesbeck, Tex., December 9, 1929. Solid lines represent the ascent, and broken the descent

Groesbeck, Tex., on December 9, 1929, as observed by kites. Two flights were made and the times at which the meteorograph reached the various levels are indicated, together with the corresponding wind direction and relative humidity. Note the low relative humidities in and above the inversion layer; also the change in wind direction above the inversion layer to southwest and west from south and south-southwest below this level.

During the first flight (7:51 to 9:10 a. m.) the sky was overcast with stratus clouds and misting rain was recorded from 7 to 8:10 a. m. It will be noted from the graph that the base of the clouds "lifted" from 250 meters at 7:53 a. m. to 550 meters at 9:05 a. m.

By the time the second flight was started (1:13 p. m.) the cloudiness had diminished to less than one-tenth. It will be seen from the graph that the inversion, although less pronounced, persisted after the clouds had disappeared.

The progressive warming of the air from the ground to the top of the inversion level until the inversion itself was considerably reduced is strikingly shown in the graph and illustrates that in this case, at least, the inversion was not a result of the cloud layer but that the upper limit of the latter was determined by the inversion.

Precipitation Records at Santa Rita, New Mexico, Range Reserve [reprinted from Forest Service Branch of Research for February, 1930 (mimiographed)].—Another phase of the rainfall study deals with the variation in amount of precipitation between stations that are comparatively short distances apart. The data for this was secured by placing rain gages at various points over the reserve (five in each of the mesa and semidesert type and six in the foothill type). The records start with the summer of 1922 and show rainfall by months up to the present time. The summer precipitation (July to September, inclusive) in the foothill type is given in the table below together with the elevation of each station and a table of air-line distances between the stations is also given.

Summer rainfall, July to September, inclusive, in Santa Rita, N. Mex., Range Reserve for the years given (inches and hundredths)

Stations	Altitude	1922	1923	1924	1925	1926	1927	1928	1929	Average
	Feet									
White House	3,900	8.04	14.34	3.64	5.12	8.60	11.28	8.23	11.52	8.85
Forest	4,200	8.66	15.11	4.10	4.19	10.71	8.65	5.56	13.13	8.76
Florida station	4,300	8.04	14.53	5.13	6.59	12.08	9.25	7.26	17.31	10.02
Parker	4,700	9.08	13.26	7.03	8.11	8.46	8.63	8.26	15.95	9.85
Proctor	4,200	9.44	10.92	6.37	9.63	7.90	8.57	8.59	11.63	9.18
Ruelas	4,500	------	------	5.75	9.52	8.16	12.50	5.66	9.18	8.89
Average	------	8.65	13.63	5.34	7.19	9.32	9.81	7.26	13.12	9.30

Air line distance in miles between stations

	White House	Forest	Florida station	Parker	Proctor	Ruelas
White House	0	2.1	2.2	4.1	5.1	6.6
Forest	2.1	0	.6	2.0	3.4	5.1
Florida station	2.2	.6	0	2.0	3.6	5.6
Parker	4.1	2.0	2.0	0	2.3	4.3
Proctor	5.1	3.4	3.6	2.3	0	2.1
Ruelas	6.6	5.1	5.6	4.3	2.1	0

The range in elevation is from 3,900 to 4,700 feet while the greatest distance between stations is 6.6 miles. Generally speaking, elevation appears to play the most important rôle in determining the amount of rainfall recorded; however, there are many instances where it has very evidently not been the prime factor. Location of the stations with respect to the highest part of the Santa Rita Mountains undoubtedly has an influence though observations have indicated that it is very erratic. Explanation of the variations would require records covering a much longer period of time and the most important feature at the present time is that we realize the possible extent of rainfall variation in connection with our range improvement and range maintenance studies. Years of plentiful rainfall may minimize the significance of these variations somewhat, but in average or below average years there is every indication that they are a most important factor in the interpretation of results obtained in our studies of the vegetation. The variation of over 4 inches between Forest and Florida stations in 1929 was perhaps relatively insignificant but the variation of almost 2½ inches in 1925 (with total rainfall roughly a third of that which occurred in 1929) unquestionably exerted a profound influence upon both density and height growth of vegetation. The total amount of rainfall for any given season is only a small part of the story since its distribution throughout the period is equally as important and can only be determined by actual measurements. * * *

A few tropical cyclones cross the plateau of Mexico.[2]—It is the rather general belief that tropical cyclones can not cross high hills or mountains. The author of this article shows rather conclusively that it is possible to trace the progress of tropical cyclones across the Mexican central plateau. Following are the dates of crossing during the period 1921–1929:

I. Sept. 19–27, 1921.
II. Sept. 12–20, 1922.
III. Oct. 10–19, 1923.
IV. Sept. 7–17, 1924.
V. Sept. 15–22, 1925.
VI. Nov. 10–14, 1925.
VII. Sept. 26–29, 1926.
VIII. Sept. 5–11, 1927.
IX. Sept. 12–25, 1928.
X. Sept. 14–22, 1929.

The tracks of each of the above-mentioned have been charted and the discussion of them is rather full.—*A. J. H.*

Mud shower in North Carolina.—Mr. Paul Hess, in charge of the Weather Bureau station at Wilmington, N. C., sends us a clipping describing a shower of mud that fell at Edenton, N. C., on April 7, 1930. The fall was light, only sufficient to give a speckled appearance to objects on which it fell.

Showers are occasionally reported in which more or less dust is mixed with the rain and sometimes the dust fall is not attended by rain.[3] Showers in which organic matter is found are sometimes reported, see for example the article by W. L. McAtee on Showers of Organic Matter, May 1917, REVIEW.

In January, 1895, a very general dust fall was reported from Indiana and neighboring States, it fell on a snow cover and it was therefore an easy matter to obtain samples, of which more than 100 were collected, some of which were analyzed. The analysis showed a silt content of fully 96 per cent, the remaining 4 per cent being made up of organic matter; some samples being richer than others in organic content and the silt being also finer in some samples than in others.

The light soil of the Plains States is easily raised, carried by strong winds and deposited many miles from the place of origin; the very finest portions of the silt are generally supposed to descend only in fog, rain, or snow, and quite likely the mud rain at Edenton was caused in a like manner.—A. J. H.

Meteorological summary for Chile, April, 1930 (by J. Bustos Navarrete, Observatorio del Salto, Santiago, Chile).—

[2] Rafael Lucio in Revista de Meteorologia Y Aerologia, Vol. 1, No. 6 pp. 114–128.
[3] Cf. this REVIEW, 58: 65.

With April came the beginning of the rainy season in the central region of Chile. The atmospheric circulation over the Pacific showed moderate intensity, but the mean path of the depressions was shifted more to the north.

The depressions of greatest importance were charted as follows: 12th to 17th, crossing the extreme south and causing unsettled weather with general rains in the south; and 24th to 26th, affecting conditions over the entire central region, with rain and high wind from Chiloe to Coquimbo. Snow fell to moderate depths in the cordillera and a temperature of 19° F. was recorded at Portillo (10,500 feet).

Periods of fine weather and fall in temperature accompanied the anticyclones of the periods 1st to 8th, 21st to 24th, and 28th to 30th, all moving from southern Chile, latitude 40° to 45° S., toward northern Argentina.—*Translated by W. W. R.*

Meteorological station at Portillo, Chile.—In April the Observatorio del Salto, Santiago, Chile, installed a new meteorological station at Portillo in the cordillera of the Andes at an elevation of 3,000 meters (9,840 feet). This station is equipped with instruments for the automatic recording of pressure, temperature, humidity, direction and force of wind, and precipitation.—*J. B. N.*

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING MAY, 1930

By HERBERT H. KIMBALL, Solar Radiation Investigations

For reference to descriptions of instruments and exposures, and an account of the method of obtaining and reducing the measurements, the reader is referred to this volume of the REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged slightly above the normal intensity for May at Washington and Lincoln, and close to normal at Madison.

Table 2 shows an excess in the total radiation received on a horizontal surface at Washington, New York, and Chicago, a deficiency at Lincoln, Twin Falls, and Fresno, and close to the May normal at Madison.

Skylight polarization measurements obtained on 7 days at Washington give a mean of 53 per cent and a maximum of 62 per cent on the 29th. At Madison measurements obtained on 6 days give a mean of 55 per cent with a maximum of 63 per cent on the 2d. These are close to the corresponding averages for May at Washington and slightly below at Madison.

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